ON A STONY METEORITE, WHICH FELL NEAR FELIX, PERRY COUNTY, ALABAMA, MAY 15, 1900.

By George P. Merrill,
Head Curator, Department of Geology.

The meteorite here described fell about 11.30 a. m. on May 15, 1900, near Felix, Alabama. For the details concerning the fall, as well as for securing the specimen itself, the United States National Museum is indebted to Mr. J. W. Coleman, who visited the locality and obtained the statements of eyewitnesses. These statements, somewhat abridged, are as follows:

Mr. Robert D. Sturdevant, a farmer of Augustin, Perry County, said that while at work in his cotton field his attention was attracted by a loud rumbling noise sounding very much like thunder. It being a clear, cloudless day, he immediately looked up and saw the meteorite directly overhead. There was one very loud report, followed by two lesser ones, the appearance being compared to that of "a big piece of red-hot iron being struck with a hammer, causing many sparks to fly in all directions. After the explosion the smaller pieces popping off sounded much like a small stone or nail being thrown with great force, making a humming or hissing noise. The meteor seemed to be passing from east to west."

The main mass of the stone, weighing about 7 pounds, was subsequently brought by a colored boy to Mr. Sturdevant, who visited the locality, about half a mile away, and found that in falling it had made a hole about 6 inches deep in the soft plowed ground.

Mr. Robert S. Browning, who was on Mr. Sturdevant's place at the time of the fall, stated that, "There was a rumbling noise, followed by three loud reports much like thunder or a big gun." He compared the appearance of the meteorite to that of "a big shovel of red-hot coals being upset."

Mr. W. A. Kenan, of Benton, Alabama, some 25 miles from the place where the stone was found, stated that the report was heard in Selma,

Proceedings U. S. National Museum, Vol. XXIV—No. 1249.

Montgomery, and Marion, the latter place being about 16 miles west of Augustin.

So far as can be learned—a part of the information being obtained by Mr. Coleman from negroes—the stone at the time of the explosion broke into three pieces, the larger of which was the one brought to Mr. Sturdevant and which is said to have originally weighed about 7 pounds, as already noted. Another small piece was found, but has disappeared, and the third, if such there was, was never found. The stone, as obtained by Mr. Coleman, was broken into five pieces which weighed altogether 2,049 grams. As shown in the illustration (Plate XIII), it was about 13 centimeters in its greatest length, by 9 in breadth, and about the same thickness, and was covered except where broken, by a very thin black crust, nowhere more than half a millimeter in thickness. The color on the broken surfaces is dark smoky gray, almost black. It is very fine grained, with numerous small dark chondrules, not more than 1 to 2 millimeters in diameter at most, and with no metallic iron visible to the naked eye. The mass is quite soft and friable and resembles in a general way the stones of Warrenton, Warren County, Missouri, and Lancé, France, more closely than those of any other locality with which the author is acquainted.

The color is, however, darker than is the Warren County stone, and the chondritic structure more pronounced than in that of Lancé. It is, moreover, uniformly gray in color, and not speckled with white, as is the last named. Under the microscope the stone is seen at once to belong to the chondritic type, as is indeed evident on close inspection by the naked eye. The essential minerals are olivine, augite, and enstatite, with troilite and native iron, the silicates occurring in the form of chondrules, or associated more or less fragmental particles, embedded in a dark, opaque, or faintly translucent base, which is irresolvable so far as the microscope is concerned. The structure is pronouncedly fragmental and the stone belongs, beyond question, to the group of tuffs.

The details of the microscopic structure are as follows: In a very dense, dark gray, seemingly amorphous base are scattered various silicate minerals in the form of fragments and chondrules, and interspersed with occasional minute blebs of native iron and troilite. The chondrules are composed of olivine, enstatite, or augite, and are sometimes monosomatic and sometimes polysomatic, holocrystalline, or with a varying amount of glassy base. Interspersed with these are fragments of olivines and enstatites of all sizes, from a half a millimeter down to the finest dust. Scattered through the ground mass are proportionally large plates or clusters of enstatites, as shown in Plate XIV, fig. 1. These are very light gray in color, with poorly defined outlines and extremely irregular borders projecting into the black irresolvable material which forms the base. The enstatite chondrules are in some cases almost completely amorphous or cryptocrystalline. Fig. 2 of Plate XIV shows an impure nucleal mass surrounded by a clear transparent border of the same material. In this case the chondrule extinguishes in polarized light as a unit, and the general appearance is remarkably like that of the quartz granules which have undergone secondary enlargement in sandstones.[1]

Many of the augites show polysynthetic twinning such as was noted by Tschermak in the meteorites of Renazzo and Mezo Madras, as do also, according to the present writer's observation, those of the meteorite of Warrenton, Warren County, Missouri. The banding is in some cases so regular and the colors so light that it was at first thought such might be in part plagioclase feldspars. The forms are, however, those of augite; they lack the pellucidity of feldspars, and, moreover, sections of the mineral showing no twinning bands always extinguish parallel with the vertical axes, while those showing twinning bands give extinctions as high as 39 degrees. There is, therefore, apparently no doubt of their augitic nature. (See Plate XIV, fig. 2.)

The most striking features of the stone are the extremely irregular, almost amorphous, areas shown in figs. 4, 5, and 6 of the same plate. These seem in a general way to resemble the amorphous chondrules described by Tschermak from the meteorite of Grosnaja and figured on Plate 20, fig. 2 of his *Mikroskopische Beschaffenheit der Meteoriten*. They present, however, certain features such as suggest quite a different origin.

In fig. 4 the outlines are very jagged, sharp crystal points projecting into the black ground mass and the whole made up of an extremely fine aggregate of nearly colorless, faintly polarizing granules interspersed with a few black spots. Fig. 5, on the other hand, is that of a nearly amorphous or faintly cryptocrystalline mass. Fig. 6, which is one of the most striking, shows a distinctly crystalline border with an interior crystalline aggregate merging outward into cryptocrystalline matter, as in the last case. The border, as shown when the body is viewed between cross nicols, belongs to a different and probably earlier stage of crystallization than the interior, and were the rock a terrestrial tuff, I think beyond question a majority of petrographers would regard the entire aggregate as secondary, and as due to a deposit in a preexisting cavity through infiltration of solutions. The exact character of the mineral comprising these areas can not with certainty be

[1] Tschermak described a like border in the chondrules of the meteorite of Grosnäja. He accounted for it by supposing it to be of secondary origin, a product of a second rise in temperature (accompanied it may be reducing vapors) not sufficient to produce fusion, but merely to bring about a structural modification in the superficial portions. (Min. u. Pet. Mittheil. I, 1878, p. 160.)

made out. It is colorless, polarizes in light and dark shades only, shows no satisfactory crystal outlines or cleavage, and in but one instance was I able to get what was apparently one of the bars of a biaxial interference figure. They are perhaps feldspathic. Their small size (the entire aggregate in fig. 6 being only some four-tenths of a millimeter in diameter) renders their separation for microchemical tests practically impossible.

Others of these areas are so finely cryptocrystalline and merge so gradually into the ground mass that it is scarcely possible to consider them as mechanically included fragments.

The chemical composition of the stone is shown in the analyses given below, as made in the laboratory of the department by Dr. Peter Fireman.

By treatment with solution of the double salt of mercuric ammonium chloride, after the method of Carl Friedheim,[1] there was obtained:

	Per cent.
(*a*) Metallic portion	3.04
(*b*) Nonmetallic portion (including troilite and chromite)	96.96
	100.00

The metallic portion yielded:

	Per cent.
Fe	85.04
Ni	11.93
Co	2.79
Cu	0.24
	100.00

The silicate portion was digested with hydrochloric acid and sodium carbonate solution after the usual method. The soluble and insoluble portions then yielded results as below, deducting those constituents present in combination, as troilite, chromite, or as free carbon.

Soluble silicate.

	Per cent.
SiO_2	32.91
Al_2O_3	2.73
FeO	34.74
MnO	0.94
NiO & CoO	1.39
CaO	6.43
MgO	19.39
K_2O	0.11
Na_2O	0.70
H_2O at 110°	0.22
	99.56

Insoluble silicate.

	Per cent.
SiO_2	53.59
Al_2O_3	6.97
FeO	3.50
CaO	4.33
MgO	31.33
K_2O	0.34
Na_2O	0.63
	100.69

[1] Sitz. d. k. Preuss. Akad. der Wissenschaft 1888, p. 345.

From these analyses the total chemical composition of the entire stone was calculated as follows:

Fe	2.59	Metallic portion=3.04 per cent.
Ni	0.36	
Co	0.08	
Cu	0.01	
SiO_2	33.57	Stony portion=96.96 per cent.
Al_2O_3	3.24	
Cr_2O_3	0.80	
FeO	26.22	
FeS	4.76	
MnO	0.68	
NiO & CoO	1.01	
CaO	5.45	
MgO	19.74	
K_2O	0.14	
Na_2O	0.62	
C (Graphite)	0.36	
H_2O at 110°	0.16	
	99.79	

Specific gravity, at 30° c, as determined by Mr. Tassin, 3.78.

The mineralogical composition may therefore be given as follows:

	Per cent.
Metal	3.04
Troilite	4.76
Chromite	1.17
Graphite	0.36
Soluble silicate (olivine in part)	72.60
Insoluble silicate (enstatite and augite in part)	18.07
	100.00

There are certain points of these analyses which I am unable, at present, to satisfactorily explain. The insoluble portion may be considered as essentially enstatite and an aluminous monoclinic pyroxene, and the soluble portion as largely olivine. But the high per cent of iron protoxide (FeO) as well as the lime and alumina in this latter portion, are not easily accounted for. It is possible that the last two elements may be constituents of the colorless, undetermined mineral referred to, but the source of the iron protoxide is for the present unexplainable.

The case is, however, not without precedent. J. Lawrence Smith reporting[1] similar conditions in the Warrenton, Warren County, Missouri, stone, which, however, he allows to pass without comment.

[1] Original Researches in Mineralogy and Chemistry, p. 532.

For purposes of comparison, I give below the analyses of the soluble and insoluble silicate portions of the Felix and Warrenton meteorites:

Constituent.	Felix.		Warrenton.	
	Soluble silicates.	Insoluble silicates.	Soluble silicates.	Insoluble silicates.
SiO_2	32.91	53.59	33.02	56.90
Al_2O_3	2.73	6.97	0.12	0.20
FeO	34.74	3.50	37.57	10.20
MnO	0.94	....	....	....
NiO	1.39	....	1.54	....
CoO		....	0.31	....
CaO	6.43	4.33	Trace.	7.62
MgO	19.39	31.33	28.41	22.41
K_2O	0.11	0.34	....	....
Na_2O	0.70	0.63	0.07	1.00
	99.34	100.69	101.04	98.33

The dark color of the rock is undoubtedly due to the carbon it contains, since the amount of iron and troilite, as shown by the analyses, is extremely small. More than that, the finely pulverized rock, after having been subjected to prolonged digestion in hydrochloric acid and sodium carbonate solution, still shows minute black, amorphous, and opaque flakes distributed through it, which are presumably carbon in the form of graphite. The stone evidently belongs to Brezina's class of *Kügelchenchondrites* and to Meunier's group of *Ornanites*. It will be known as the Felix meteorite.

I am indebted to Dr. F. Berwerth, of the k. k. Hof Museum at Vienna, for a fragment of the Lancé meteorite for comparison, and to the Shepard collection for material for thin sections of the Warren County stone.

EXPLANATION OF PLATES.

Plate XIII.

Figs. 1 and 2. Felix meteorite. The size is indicated by the centimeter rule below each figure.

Plate XIV.

Fig. 1. Enstatite plates in ground mass. The black in this and in figs. 5 and 6 is a little too dense. It is intended to show the dark, irresolvable base.

Fig. 2. Monosomatic enstatite chondrule with clear, colorless border.

Fig. 3. Twinned augite.

Figs. 4, 5, and 6. Colorless, granular, and cryptocrystalline areas of an undetermined mineralogical nature, which it is thought may be of secondary origin. The actual size of the particles figured on this plate in no case exceeds 0.5 mm.

Fig. 1.

Fig. 2.

THE FELIX METEORITE.

FOR EXPLANATION OF PLATE SEE PAGE 198.

Fig. 1.

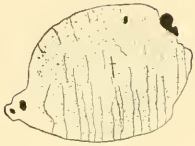

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

THE FELIX METEORITE.

FOR EXPLANATION OF PLATE SEE PAGE 198.